Investing in the Future of Jobs and Skills

Scenarios, implications and options in anticipation of future skills and knowledge needs

Executive Summary
Chemicals, Pharmaceuticals, Rubber & Plastic Products

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Overview

This executive summary highlights the main results of the final report *Investing in the Future of Jobs and Skills. Scenarios, implications and options in anticipation of future skills and knowledge needs in the Chemicals, Pharmaceuticals, Rubber and Plastics Sector*. Apart from analysing sector trends, the study explores four scenarios and their implications for jobs, skills and knowledge in the year 2020. The study is both forward- and backward-looking. It further presents options and recommendations to address future skills and knowledge needs, aimed at firms, sector organisations, education and training institutes, policy-makers and other stakeholders. This study appears in a series of 16 other sector studies.

The study should be placed against the background of the EU's renewed Lisbon Strategy for Growth and Jobs and the recently launched New Skills for New Jobs initiative. Investing in people and modernising labour markets is one of the four priority areas of the Lisbon Strategy. The New Skills for New Jobs initiative presents a very first assessment of the EU's future skills and jobs requirements up to 2020. The initiative aims to help ensure a better match between the supply of skills and labour market demand and to improve the Member States' capacity to assess and anticipate the skills needs of its citizens and companies.

The chemicals industry – main characterisation

The European chemicals sector broadly defined is a major contributor to the EU economy in terms of output, trade balance and employment. In 2006 it accounted for approximately 100.000 enterprises in the EU-27, employing 3.75 million persons. 1.92 million of which work in the chemicals and pharmaceuticals industry and 1.83 million in the rubber and plastics industry. Altogether the sector represents 1.7% of overall EU employment and 10.9% of total EU manufacturing employment. Total sales amounted to € 799 bn, with chemicals being the largest sector representing 46.4% of total sales, followed by rubber and plastics, and pharmaceuticals accounting for 23.1% and 30.5%, respectively. In terms of value added the sector generated € 322 bn or 2.8 % of overall GDP in 2006.

The sector supplies products to almost all other industry sectors and is an important engine for innovation in the wider economy. It plays a key role in facilitating and improving product performance and new applications in various industries. Despite being a global leader in exports, the EU chemicals industry's competitiveness is under threat due to relatively high cost of production, low market growth, less than optimal innovation performance, delocalisation of user industries and the build-up of efficient large-scale capacity elsewhere in the world. Globalisation also provides new opportunities for the sector and society in Europe, as does emerging demand for greener products under influence of climate change and increasing scarcity of resources (oil, gas and energy). Innovation and the search for sustainability are key drivers in maintaining competitiveness. The design and manufacturing of high added value products and increased eco-efficiency are major challenges for European industry that will continue to exist in the near future. In coping with the huge environmental, population and energy challenge ahead, the chemicals sector is a key solutions provider.

Main economic and employment trends

Production. During the last ten years, EU-27 production of chemicals, pharmaceuticals, rubber and plastics manufactures has risen steadily and continuously up and until 2006. The rate of growth outpaced the industrial average with 4.0 % against 2.3 % overall. Germany is the largest chemicals producer in Europe by output, followed by France, Italy and the UK.

Together, these four countries produced 62% of EU chemicals output in 2006. Adding Belgium, Spain, the Netherlands and Ireland raises the share to 88%.

The strongest expansion in EU-27 output occurred in pharmaceuticals, with an increase of 6.1% annually in ten years up to 2006, followed by basic chemicals (+3.7%). In contrast, contractions were observed in pesticides and other agro-chemical products, and man-made fibres (minus 2.4 % annually), with most of the declines occurring between 2001 and 2005. Output of rubber and plastics has gone up since 2001 with annual growth rates ranging between 0.2% (2002) and 4.1% (2006).

Value added. The lion share of the €322 bn value added in the sector is generated in the EU-15 (95%), with only 5% generated in the new Member States (NMS). However, the NMS have shown much faster growth (+6.1% annually) than the EU-15 (+3.9%). An interesting specialisation trend within the EU can be observed at the sub-sector level. While the EU-15 grew much stronger in chemical products and pharmaceuticals (4.5% per year) than the overall economy (2.8%), the NMS expanded strongly in the rubber and plastic products sector. This applies especially to the Czech Republic, Hungary, Poland, Slovakia and Slovenia.

Value added trends, 1995-2006

	Sector				Overall economy			
	Value added	Value added growth			GDP	Value added growth		
	2006	95-00	00-06	95-06	2006	95-00	00-06	95-06
	million €	%	%	%	million €	%	%	%
EU	322 322	4.6	3.5	4.0	11 468 970	2.8	2.0	2.3
EU-15	306 629	4.6	3.3	3.9	10 883 245	2.8	1.9	2.3
NMS	15 693	5.1	6.9	6.1	585 725	2.7	3.7	3.2

Employment trends, 1995-2006

	Employment level	Average annual growth (%)	Share in EU sector employment (%)	Change in share in EU sector employment (%)
	2006	95-06	2006	95-06
EU	3 746 869	-0.1	100	0
EU-15	3 027 272	-0.4	81	-1
NMS	719 597	1.6	19	1

Source: Eurostat/TNO. GDP: Gross Domestic Product.

Employment. The largest share of employment, in line with production and value added, is found in the 'old' EU-15 (81%). However, compared to the share of value added (5%) the new Member States have a much higher share of employment (19%). Overall the sector experienced an employment decline despite large output increases. For the period 1995-2006, annual employment growth was slightly negative in the EU-15 (-0.4%) compared to positive growth in the new Member States (+1.6%). Clear winners in employment performance were France, Italy, Denmark, Ireland and the Czech Republic.

Employment in chemicals and pharmaceuticals decreased by 1%, while employment in rubber and plastic products increased by 1%. Employment growth in the new Member States was particularly strong in rubber and plastics (6.4%). Large firms dominate the sector providing half or more of sector employment across Member States. However, strongest employment growth occurs in the medium-size firm segment. Generally, a trend from lower skilled to high skilled employment across sectors is observed, with high levels of global competition having driven further consolidation of the sector.

The EU-15 workforce in the sector is structurally older than in other sectors. This is likely to have been caused by restructuring efforts over the last decade. As many technical functions

require tacit knowledge, the lack of younger employees potentially poses a skills gap when the older generation retires over the coming years. Currently plant and machine operators represent the largest share of employees in both the EU-15 (21%) and new Member States (23%). Other important occupations are engineers, business and other professionals, secretaries and labourers. Relatively small shares are taken by service workers and computing professionals. Interestingly is the share of technical executing occupations (metal, machinery, precision workers and labourers) which is with 55% much higher in the new Member States than in the EU-15 (44%).

Employment trends by job function: shares (2006) and changes in shares (in%), 2000-2006

	Shares, 2006			Changes in shares, 2000-2006		
	EU-15	NMS	EU	EU-15	NMS	EU
Managers	10	9	10	0	0	0
Computing professionals	2	1	2	1	3	1
Engineers	13	11	13	1	3	1
Business professionals	8	6	7	2	-7	0
Other professionals	11	11	11	-2	-2	-2
Office clerks and secretaries	12	7	11	0	0	0
Service workers	1	2	2	0	0	0
Metal, machinery, precision workers	7	10	8	0	1	0
Craft, trades	4	5	4	0	0	0
Chemical prod machine operators	1	3	1	0	1	0
Rubber, plastic prod. mach. operators	2	2	2	-1	5	0
Plant, machine operators	21	23	21	-1	-3	-1
Labourers	9	12	9	1	1	1
Total	100	100	100	1	1	1

Source: Eurostat Labour Force Survey/TNO

Job function trends by education level: changes in shares (in %), 2000-2006

	Low educated			Medium educated			High educated		
	EU-15	NMS	EU	EU-15	NMS	EU	EU-15	NMS	EU
Managers	-1	-1	-1	1	2	2	0	-1	0
Computing professionals	-4	0	-4	-10	-8	-10	15	8	13
Engineers	1	0	0	4	-14	3	-5	14	-3
Business professionals	0	0	-1	-3	-27	-5	3	27	6
Other professionals	-1	-3	-1	-2	-1	-4	3	4	5
Office clerks and secretaries	-2	-1	-2	0	-1	0	2	2	2
Service workers	-14	-6	-12	5	-13	1	9	20	12
Metal,machinery,precision workers	-1	-4	-2	0	4	2	1	0	1
Craft, trades	-2	-8	-4	4	13	7	-2	-4	-3
Chemical prod machine operators	2	-14	-6	-4	14	4	2	0	1
Ditto, rubber, plastic products	-9	-39	-16	7	37	13	2	2	2
Plant, machine operators	-5	-11	-7	3	12	6	2	0	2
Labourers	-8	-12	-9	7	12	8	1	0	1
Total	-4	-7	-5	1	3	2	3	4	3

Source: Eurostat Labour Force Survey /TNO

In almost all job functions a decrease is observed among the low educated employees. This is most pronounced in technical occupations traditionally occupied by low educated workers, notably metal, machinery and precision workers and labourers. While in the EU-15 the category of service workers declined most severely (-14%), in the new Member States the number of chemical and rubber and plastic products machine operators in the low-educated

segment shrunk dramatically. This can be explained by a strong trend of up-skilling, with a strong expansion of mid-educated workers in the same occupation. Similarly, the number of mid-educated in occupations such as business professionals and engineers in the new Member States, and computing professionals in the EU-15 show strong declines: -27%, -14% and -10%, respectively. Increasingly these occupations are manned by high educated workers, proof of a general trend of up-skilling of functions previously occupied by mid-educated workers. Almost all occupations experience an expanding share of high educated workers, particularly computer professionals and service workers.

Trade and international competition. The EU is a global export leader in chemicals. Both exports and imports have grown considerably in the period 1995-2006. The growth in exports was most vigorous in the new Member States, with over 11% annually, yet with imports growing even faster - almost 12%. Nevertheless, the EU chemicals industry's competitiveness is under threat due to relatively high cost of production, low market growth, lagging innovation performance, delocalisation of user industries and the build-up of efficient large-scale capacity elsewhere in the world. The EU's main competitors in chemicals are the US, Japan and the BRICs. Both the US and Japan experience similar structural pressures as Europe due to newly emerging competitors, notably China. The EU-15 clearly outperformed the US and Japan in employment growth (1995-2005). The BRICs show aggressive growth, especially in fine chemicals and in rubber and plastics. The BRICs, together with the Middle East and other Asian countries have built up considerable production capacities which could lead to even fiercer competition in global export markets in the future.

SWOT analysis

The SWOT analysis provides an overview of perceived Strengths, Weaknesses, Opportunities and Threats of the sector. Strengths and weaknesses are usually taken as sector-internal factors that create, respectively destroy value. For a company these can include assets, skills or resources that a company has at its disposal, compared to competitors. Similarly, opportunities and threats are external factors that can create or destroy value. They emerge from company dynamics, the industry/market at large and are driven by demographic, economic, social, technical, social, cultural, ecological or legal/political factors (DESTEP).

SWOT Analysis	
Strengths	**Weaknesses**
• Strong internationalisation of firms • Competitive industry • Historically strong research base – high quality engineers / university research • Research intensity pharma / biotech • Technology leader (efficiency) • Close integration / clustering of chemicals activities creating a favourable locus and infrastructure for production and innovation • Strong in specialty chemicals / pharmaceuticals • Low cost production locations in new Member States close to EU-15 market (rubber and plastic products) • Capital intensity – prevents short term relocation of production activities.	• Lagging innovation performance in bringing new products successfully to the market • Comparatively weak biotech research compared to US – important for pharmaceuticals sector • Structurally higher resource costs (oil, gas, energy) • High labour costs for low skilled jobs (rubber / plastics manufacturing) • Ageing work force, few young newcomers • Single European market for chemicals and energy still largely lacking in Europe • Structure of EU IPR system increases costs • Dominance of relatively small plant size in Europe leading to scale disadvantages • Public perception of chemicals industry mixed, leading to a lack of interest in chemical education • Transport infrastructure: congestion / weak

	pipeline infrastructure, EU-15 and esp new Member States (pipelines, ports, railways).
Opportunities	**Threats**
• Emerging markets – provision of export / new markets • Demand for basic chemicals when industrialising • Demand for pharmaceuticals as developing countries get richer and industrialised age • Solutions required for environmental challenges / technologies – chemicals as solution provider • Efficiency leader → technology exports / competitive advantage once stricter global regulation comes in force • New technologies such as biotech and nano-tech; substitutes for oil inputs and new materials with higher performance characteristics • Presence of user industries • Regulation also conducive to future development of sector.	• Competition from emerging economies – declining trade surplus in (basic) chemicals • Growth markets outside Europe • Labour supply declining – particularly high skilled technical personnel • Lack of interest in chemical education • Weakening position of EU university education and research for the sector • IPR violations particularly in pharmaceuticals • Unilateral European regulation REACH and ETS structurally increase production costs • Relocation of user industries • High energy / resource costs • Safety and security issues, esp in densely populated areas • Small / creative start-ups are easily bought up for strategic reasons. IPR does not help to protect their IP.

Source: TNO-SEOR-ZSI-MICORD

Main drivers of change

Using a meta-driver approach based on various sector and economy-wide studies and expert knowledge, 26 drivers were assessed. The most important drivers identified include innovation and sustainability; emerging economies driving global growth; outsourcing and offshoring of user industries; increasing demand for environmentally friendly ('green') products; availability and price of oil, natural gas (methane) and energy; environmental, security and safety regulation; and the quality of institutions (including reliability, quality and enforcement of rules and regulations). Other important drivers include ageing (retiring baby boomers, fewer younger workers); household income; global competition and increasing market segmentation.

Regulation affecting the present and future of the sector stems from several current legislative initiatives such as REACH, the Environmental Liability Directive and legislative responses to climate change including the ETS Directive (greenhouse gas (GHG) emissions allowance trading system). The chemicals industry is further affected by the offshoring of user industries which leads to new investments in plant capacity outside Europe. Outsourcing plays an increasingly important role in the pharmaceuticals industry, while offshoring and low wage production is important for the rubber and plastic products sector (also within the EU). The demand for environmentally friendly (green) products is particularly important for the chemicals industry as supplier of materials and solutions for new technologies. Both the availability and price of carbon and energy is important, and crucial for energy intensive subsectors such as basic chemicals. Lastly, the sector depends on quality institutions and a

stable political environment, needed for large capital investments (chemicals) and high research intensity (pharmaceuticals).

Global competition has up to the current crisis been fuelled by very low tariffs and an integrating world market. At the global scale firms have been able to exploit scale advantages leading to M&A driven consolidation. Furthermore, with emerging economies breaking into upstream activities (basic chemicals), competition has intensified, also based on resource advantages. Increasing market segmentation can be seen as a response to the global competitive pressures, with firms focusing their activities on market niches that provide higher value added activities. Income per capita is an important driver. With the sector being an important supplier of various downstream industries, an economic surge means favourable conditions for a boom in the chemicals sector. When the economy and hence incomes expand, so does the demand for chemicals. The reverse, now being faced with a serious economic downturn, also applies.

Scenarios and implications for employment

Four future scenarios have been constructed and explored: 1) *Green and Global,* 2) *Green and Focus Europe,* 3) *European Retreat*, and 4) *Global Pressure* (see figure below). The scenarios depict plausible and credible futures for the chemicals industry in Europe by 2020. Rather than predictions or forecasts based on a model, the scenarios outcomes in this study are based on expert opinion. The bandwidth between the most extreme scenarios can be interpreted as indicative for the degree of uncertainty indicating possible future paths.

Construction, hypotheses and use of the scenarios

In constructing the scenarios, a clear distinction has been made between exogenous and endogenous drivers, the main difference being the scope and ability for direct influence. Exogenous drivers are drivers that form a "given" for the sector without much room for influence for and by individual actors. Endogenous drivers are drivers that can be influenced at the sector level, for instance by national or European policy-making, or collective effort from within the sector. In constructing the scenarios, those drivers have been selected that scored high on the criteria relevance, impact and uncertainty.

The scenarios apply to the chemicals sector broadly defined, but exclude the pharmaceuticals sector. The sub-sectors differ in their future development paths, as they face very different dynamics in terms of market structure and developments. The way the scenarios have been constructed does not preclude such differentiation. Note that demographics – ageing (less young, more retirees) – and its effects on labour supply have not explicitly been identified in selecting the drivers, as demographics in the time frame of 2009-2020 are relatively certain (i.e. predictable). They do play a role in all scenarios, however. Education and training which can also be perceived as a set of endogenous factors have been excluded from the scenarios. They are together with a number of other strategies and/or policies discussed as solutions in response to the scenario outcomes.

Scenario I: *Green and Global*

> *Green and Global* represents a world characterised by strengthening international competition and strong global and European economic growth. An increase in demand for greener demand coincides with adequate policy support, lead market initiatives and more and smarter innovation by the EU chemicals industry, especially in bio-based 'green' chemistry and materials. Europe thrives in improving its environmental, security and safety regulations with more flexibility and targeting. As a result Europe is able to build up and specialise in global niches, with even more energy efficient processes driven by

cluster integration. Further deepening of EU integration and effective checks and balances warrant further European growth. In a world characterised by strengthening competitive pressures due to further globalisation and multilateral trade, European firms are able to compete, further specialise and focusing on core activities and grow.

Scenario II: *Green and Focus Europe*

Green and Focus Europe combines a slowdown of global economic growth with increasing protectionism and trade regionalisation in which competition and trade more and more evolves within rather than between trade blocks. Slowing growth predominantly results from continued upward shock-wise pressures in the oil, gas and energy markets which make both international business activity and transport more expensive. Europe sustains its high quality institutions and establishes a true European single market, also in services. High energy prices and disruptions in international supply chains increase the competitiveness of substitutes, and lead to market-driven adoption of green technologies and innovation. Consumers opt for energy efficient products. The chemicals industry plays a key enabling role. A pro-active dialogue between government and industry (collaborative 'co-thinking') enables a better and smarter tailoring of existing environmental and security and safety regulations. *Green and Focus Europe* results in a greater and greener variety of products but a stronger focus on home market Europe.

Four future scenarios for the chemicals industry and main underlying drivers

		Endogenous, sector-specific drivers: - Sustainability and innovation - Integration / integrated chemical clusters - Environmental regulation - Security and safety regulation - Quality of institutions		
		- EU lead markets in sustainability with strong policy support and strong innovation - Active integrated cluster strategies - Environmental regulation based on pro-active two-sided 'co-thinking' dialogue with industry - Ditto safety & security regulation - Sustained quality institutions, continuing EU integration (deepening)		
Exogenous drivers: - Outsourcing & offshoring of user industries - International competition; emerging economies driving global growth - Market segmentation and green demand (environmentally friendly safe products and feedstock) - Availability/price of oil, gas and energy - Income	Increasing modestly Moderating, more inward-looking / protectionist More segmentation, strong increase in autonomous green demand Continuing price increases (scarcity & politically driven) Slow growth	Green and Focus Europe (S-II)	Green and Global (S-I)	Increasing strongly Strengthening Moderate increase in segmentation, and in autonomous green demand Moderate price increases High growth
		European Retreat (S-III)	Global Pressure (S-IV)	
		- Absence of lead markets and lagging innovation performance		

Source: TNO-SEOR-ZSI

- Cluster integration taken up by business only
- One-sided environmental regulation, no proactive 'co-thinking' dialogue with industry
- Ditto of security & safety regulation
- Sustained quality institutions but 'standstill' in European integration

Scenario III: ***European Retreat***

An overall slowdown in economic growth caused by high energy prices and supply disruptions, yet with less fierce global competition characterises the *European Retreat* scenario. Whereas strong rises in oil, gas and energy prices leads to an increased demand in environmentally friendly and foremost energy-saving products, policy support to facilitate this change is minimal – a strong belief in market forces being the dominant doctrine. There is stable but less tailored regulation without any renewing and innovating policy initiatives, which prevents a real strong take-off of the 'green' segment. At the same time demand for EU-produced traditional chemicals products (the blockbusters) slows. Together this forms a dangerous mix for the future competitiveness of the EU chemicals industry. Further regionalisation and an intra-Europe focus, as well as excess global capacity in the Middle East and East Asia make that surpluses easily can make their way into European markets, with Europe losing competitiveness, especially in energy intensive, basic chemicals production. Europe does not only face a loss of global leadership in chemicals production, but will possibly witnesses a gradual retreat of production capacity throughout Europe.

Scenario IV: ***Global Pressure***

Global pressure combines strong overall economic growth and high incomes with even stronger global competition making 'all hands on deck' for the EU chemicals industry a leading adage. Strong economic growth is engendered by continuing and expanding global trade flows in combination with a stable slowly upward development of global oil and energy prices. Globalisation, however, also stimulates further international competition in chemicals (Middle East, East Asia, Russia). Europe's competitors are able to produce high-quality chemical goods at structurally lower prices. Stable but less tailored regulation without any renewing and innovating policy initiatives and institutional stagnation (no further deepening of the internal market) will add to the increased competitive pressures internationally. Excess global capacity and low EU tariff barriers make that surpluses make their way into European markets. This results in a further squeeze of EU market shares and profit rates, with European producers gradually losing global leadership.

Implications of scenarios for jobs, skills and knowledge by job function

Volumes by job function, 2020. Although the direction of each of the scenarios is different, the implications of both scenarios in terms of overall employment volume in 2020 are assessed to be rather similar for the more positive *Green and Global* and the *Green and Focus Europe.* The same applies for the more negative scenarios *European Retreat* and *Global Pressure*. It is the development path towards 2020 and the type of niche specialisation and therefore skills composition – resulting for instance in more SMEs in the *Green and Focus Europe* scenario than in the *Green and Global* scenario – more than the result in number of jobs that is different. Whereas the *Green and Global* scenario is the most open and global one, with most rapid change to be expected, the *Green and Focus Europe* scenario is more gradual and smooth; a same difference applies to *European Retreat* and *Global*

Pressure, respectively. *Green and Focus Europe* implies more diversification and segmentation of the market, with more (diversified) companies present in the market and more SMEs than in the *Green and Global* scenario. The former scenario, because of its stronger focus on leading-edge sustainable and safe products, will create positive employment effects similar in size to the more specialised global portfolio and generally bigger sized companies in *Green and Global*.

Implications of scenarios: job volume changes by function, 2009-2020

Job function \ Scenario	Green and Global	Green and Focus Europe	European Retreat	Global Pressure
Managers	M/D	M/D	M/D	M/D
IT professionals	M	M	M	M
Engineers	I	I	I/M	I/M
Accounting & finance	M	M	M	M/D
Sales & marketing	I/M	I/M	I/M	M
Supply change management	I	I	I/M	I/M
Administrative support staff	M	M	M/D	M/D
Production workers	M/D	M/D	D	D
Plant and machinery maintenance & repair	M/D	M/D	D	D
Labourers	D	D	D	D
Overall change in jobs	*I/M*	*I/M*	*M*	*M*

Source: TNO-SEOR-ZSI. Notes: D =decrease, I=increase, M=maintain. I/M indicates "slight increase to stabilization of work force expected"; M/D "stabilization to slight decrease of work force expected" etc.

The *Green and Global* scenario is the most challenging in terms of solutions that have to be implemented on relatively short notice basis to withstand global competition and to benefit from leading-edge new product concepts and production processes. Pre-competitive research will more and more shift to universities (in close collaboration with industry). Engineers are in high demand, as are new specialist profiles such as nanotechnologists. Supply chain management (SCM) in world-wide operations and increased collaboration with suppliers is another booming job function. SCM and engineering capacity (toxicologists!) is also needed to address and fulfill REACH needs, and hence competes also with other sectors. IT professionals will remain in demand, although services related to this job function are expected to be increasingly outsourced. Low-educated labourers are gradually but significantly substituted by capital over time, as investment in more efficient all-purpose labour replacing production units – now already visible – further proceeds. Support and finance functions continue to exist, although with more pressure on the lower skilled end. Sales and marketing efforts are increased, because of increased global profiling, with the exception of the pharmaceutical industry where current societal pressure will lead to a cut in marketing spending (rebalancing). Similar logical qualitative inferences can be made for the other scenarios, leading to volume changes as presented in the table below.

Future skills and knowledge needs by job function

For all job functions future skill needs have been identified based on six clusters of similar and related skills (see box below). Across job functions soft skills will become increasingly

important, especially for high skilled professional job functions. The general trend of up-skilling across job functions is bound to continue in the coming years. Due to the changing nature of jobs, predefined technical knowledge capabilities will become somewhat less important while skills to adapt and learn new competences and life-long learning will be put at a premium. Certain knowledge – notably e-skills – will become more important. Emerging competences of higher skilled jobs mostly refer to *how* to learn, communicate, interact and adapt to changing environments in addition to a high quality education. Emerging competences in medium-educated job functions that mostly execute defined tasks and processes refer mostly to specific knowledge sets that can be taught through learning.

Overview of skills and knowledge needs identified for each job function and scenario
Knowledge ('hard skills') • Legislative / regulatory knowledge (environmental / safety / labour / contracting); Language*; e-skills; Marketing skills; Technical knowledge; Product knowledge; Product development
Social Skills • Team working skills; Social perceptiveness (listening / understanding); Communication; Networking; Language*; Intercultural Problem-solving Skills • Analytical skills; Interdisciplinary; Initiative, Multi-skilling; Creativity Self-management Skills • Planning; Stress and time management; Flexibility; Multi-tasking Management skills • Strategic & visionary; Coaching and team building; Change management; Project management; Process optimizing; Quality management; People skills crucial for collegial management style Entrepreneurial skills • Supplier and customer relationship / understanding; Business understanding / development; Trend setting / trend spotting

Source: TNO-SEOR-ZSI

Key emerging skills and knowledge needs by job function can be described as follows[1]:

Managers - require the broadest skill set. Particularly social skills are needed to manage workers in a more non-hierarchical and networked firm environment. The expected transformation of the sector makes strong change management skills and business development skills essential.

IT professionals – focus on specific IT solutions with modelling and simulation in production and research becoming increasingly important. Programme developers require a hybrid competence of chemistry and software engineering, while users need to learn how to use the new technologies effectively for their work.

Engineers – new technological developments and sustainability make trans-disciplinary education and thinking crucial. With globally distributed production processes and R&D

[1] For expected changes in main skills and knowledge clusters, see tables below. More extensive and detailed accounts on future skills and knowledge needs can be found in the main report, with further differentiations made by scenario.

and innovation becoming more distributed between academic, industry and research actors, managing networks becomes key for engineers. Increasing regulation and HSE standards also mean that other sectors and authorities are in demand for chemically educated engineers.

Accounting and finance – with widespread IT systems for accounting and financial services, E-skills are of crucial importance in the future. Furthermore, with increasing international orientation of firms international and foreign accounting standards financial regulations become more important.

Sales & Marketing – beyond the increasing importance of soft skills that are required in most professional jobs, entrepreneurial skills, spotting market trends and opportunities are an emergent competence to highlight.

Supply chain management - is a relatively new function based on global reach of firms promising strategic advantages related to integration of purchasing, sales and logistics. It is therefore in itself an emergent competence that requires strong practical experience, combining quantitative and IT skills with trade and regulatory knowledge.

Support staff - require up-to-date e-skills to function effectively in an administrative environment. In addition, team working and communication skills, self organisation and multi-tasking are key emerging skills. *Drivers,* a sub-category of support staff, are important for supply chain efficiency. Language and regulatory differences between Member States make it difficult to find drivers fitting the requirements of transporting hazardous goods.

Production workers – mostly require technical knowledge (operating production equipment). In addition, flexibility of operations require workers to be increasingly multi skilled to be able to work in different production tasks depending on plant demand.

Plant and machinery maintenance and repair workers – mostly require technical knowledge to repair and maintain plants and machinery. These include metal related crafts skills as well as increasingly skills related to electronic aperture.

Labourers – still make up a considerable part of the workforce but were the biggest loser in terms of employment. Labourers without technical qualifications need to be up-skilled to be able to participate in the workforce in the long run. Tasks of other low educated workers (cleaning and maintenance personnel) are increasingly outsourced shifting to the service sector.

Main strategic choices to meet skill and knowledge needs

In order to meet future skills and knowledge needs, apt and timely solutions – referred to here as strategic choices - are required (see table below). Strategic choices refer and relate to the medium- and longer term, even though emerging skills and knowledge needs in practice may also apply to the now and tomorrow. Essential in seeking appropriate solutions is to keep this longer time perspective in mind. Rather than focusing on one single solution, a set of linked strategic choices will in most cases be the best strategy to follow. Prioritising both in time (what first, where to follow up) and in allocation of resources (including budgetary focus) followed by further fine-tuning is a clear necessity to guarantee that skills needs are targeted and solved. Skill needs can be identified at various levels, ranging from assessments at the national or even European sector level to more precise assessments at the regional and company level. Increasingly the identification of skills and knowledge needs but also the search for adequate solutions will have to become an integral part of an overall longer-term

business strategy, also for SMEs. Some solutions will be found within the company itself, e.g. through reorganising functions within or between plants, by offering (re)training trajectories or by active global sourcing of personnel. For SMEs and especially for micro-enterprises such longer-term, more strategic human resource management often will be more difficult to organise and operationalise.

Example. Strategic Options Decision Tool -- job function: Managers

1.	What is the maximum job volume effect*?	Maintain (bulk)/ Increase (specialty)
2.	What is the maximum change in skills (number)*?	20
3.	Do SME's play a large role?	Yes, but large firms set the stage
4.	Is the sector national/EU/global?	Global
5.	Is the workforce old?	Yes (in EU-15); younger in EU-12
6.	Is the workforce low educated?	No

Option	Is this option viable?	Actors[1]
A. Recruiting workers from other sectors	Yes, mainly for generic management skills	C, S, I
B. Recruiting workers from other Member States	Yes, mainly in Green and Global, difficult for SME's and often language barrier	C, E, G, I
C. Recruiting workers from Non-Member States	Yes, mainly large companies, less viable for SME's	C, E, G, I
D. Recruiting unemployed with or without re-training	Only in rare cases	C, I
E. Recruiting young people from the education system	Yes, mainly through apprenticeships, sector ambassadors in schools, use "sustainability" image	C, S, E
F. Training and re-training employed workers	Yes, in-house promotion and further training in the firm	C, S, E
G. Changing work organisation	Yes, team work, flexible working time arrangements (mergers, acquisitions in Green and Global scenario).	C
H. Outsourcing and offshoring	Yes, but only for large companies and only in Green and Global scenario.	C
I. Changing vocational education	No	-
J. Designing and offering new courses	Yes, mainly aimed at planning, stress and time management, business development and E-skills	C, S, E
K. Providing information about emerging skills	Not necessary	
L. Improve the image of the sector	Yes, especially sustainability image in recruiting young workers & diverse target groups (female, ethnic minorities)	C, S
M. Stronger cooperation between stakeholders	Not necessary	

Notes: C (company), S (sector organisations and chambers of commerce), U (trade unions), E (education & training), G (governments), I (intermediary organisation).* Taking the most extreme scenario.

In order to address the identified future skills and knowledge needs in an encompassing and timely manner, appropriate joint action is needed by all stakeholders, including industry (firms, sector organisations and social partners), training and education institutes, intermediary organisations and government at all levels (EU, national, regional and local).

Collaboration is needed in order to agree on and implement a package of feasible solutions. Timely, targeted and reliable information to make decisions – i.e. adequate monitoring and analysis - is an essential prerequisite.

Implications, conclusions and recommendations for education and training

Implications, conclusions and recommendations have been made at two distinct levels: 1) the individual job function level focusing on options by function. 2) for sectoral stakeholders and policy-makers the conclusions and recommendations were split in targeted recommendations for education and training and 'other' more general recommendations (see next section).

1) *Adapt and modernise vocational education and training (VET) systems and general education systems on a Member State by Member State level.* Initial and continuing VET and general (primary, secondary and tertiary) education differs considerably between Member States, in terms general set-up, organisation and implementation. Each of these have their own merits; therefore not standardisation of throughout Europe but (differently) targeted measures by Member State to adapt and modernise is required. Especially in the new Member States, more focus and assistance is required for fine-tuning.

2) *In-company training and lifelong learning are vital and need to be supported, especially for SMEs.*

3) *Collaborate with all relevant stakeholders and intensify co-operation in education and training.* Concerns information provision, development of sectoral learning strategies and establishing partnerships for innovation and job creation.

4) *Support upgrading of education and training by providing benchmarks and best practice solutions.*

5) *Improve information provision on current and future skills and knowledge needs and job requirements: essential for training and education as well as for finding employment*

6) *Provide better career guidance for those in search of a job*

7) *Increase transsectoral and transnational mobility and promote international and intersectoral acknowledgement of certificates*

8) *Enhance flexibility through modularisation of education and training*

9) *Supply special courses dedicated to sector characteristics*

10) *Supply special courses for older workers*

11) *Pay more attention to interdisciplinary and multidisciplinary skills / knowledge*

12) *Stimulate multi-skilling and strengthen intercultural and language skills.*

Scenario implications for employment: volume effects and skills and knowledge needs by job function

		Green and Global	Green and Focus Europe	European Retreat	Global Pressure
Managers	1. Employment volume change	M/D	M/D	M/D	M/D
	2. Skills changes counted	Count 20	Count 17	Count 11	Count 11
	3. Emerging skills needs	Management, Entrepreneurship, Self-management, Social skills, Knowledge	Management, Entrepreneurship, Self-management, Social skills, Knowledge	Management, Social skills, Self-management	Management, Social skills, Self-management
	4. Most important solutions	In-house development; recruiting from other sectors	In-house development; recruiting from other sectors	In-house development; recruiting from other sectors	In-house development; recruiting from other sectors
	5. Most important actors	C	C	C	C
IT professionals	1. Employment volume change	M	M	M	M
	2. Skills changes counted	Count 12	Count 12	Count 12	Count 12
	3. Emerging skills needs	Knowledge, Self-management	Knowledge, Self-management	Knowledge, Self-management	Knowledge, Self-management
	4. Most important solutions	Recruit, (Re-)train,	Recruit, (Re-)train,	Recruit, (Re-)train,	Recruit, (Re-)train,
	5. Most important actors	C, E	C, E	C, E	C, E
Engineers Production & R&D	1. Employment volume change	I	I	I/M	I/M
	2. Skills changes counted	Count 21 (22)	Count 22 (23)	Count 16 (16)	Count 16 (16)
	3. Emerging skills needs	Knowledge, Problem Solving, Social Skills, Entrepreneurship	Knowledge, Problem Solving, Social Skills, Entrepreneurship	Self-management, Management, Social Skills	Self-management, Management, Social Skills
	4. Most important solutions	Recruit, (Re-)train	Recruit, (Re-)train	Recruit, (Re-)train	Recruit, (Re-)train
	5. Most important actors	E, C	E, C	C, E	C, E
Accounting & Finance	1. Employment volume change	M	M	M	M/D
	2. Skills changes counted	Count 11	Count 10	Count 8	Count 9
	3. Emerging skills needs	Knowledge, Self-management, Social	Knowledge, Self-management, Social	Knowledge, Self-management	Knowledge, Self-management
	4. Most important solutions	Recruiting, Training	Recruiting, Training	Recruiting	Recruiting
	5. Most important actors	S, E, C	S, E, C	S, E, C	S, E, C
Sales & marketing	1. Employment volume change	I/M	I/M	I/M	M
	2. Skills changes counted	Count 17	Count 17	Count 9	Count 9
	3. Emerging skills needs	Entrepreneurship, Knowledge, Self-management	Entrepreneurship, Knowledge, Self-management	Social skills, Self-management	Social skills, Self-management
	4. Most important solutions	(Re-)training	(Re-)training	(Re-)training	(Re-)training
	5. Most important actors	C	C	C	C

C=Companies; S=Sectoral organisations, U=trade Unions; E=Education and training institutes; G=Government (EU, Member State, regional, local).

Scenario implications for employment: volume effects and skills and knowledge needs by job function

		Green and Global	Green and Focus Europe	European Retreat	Global Pressure
Supply chain management	1. Employment volume change	I	I	I/M	I/M
	2. Skills changes counted	Count 13	Count 13	Count 13	Count 13
	3. Emerging skills needs	Knowledge, Social Skills, Problem-Solving Skills	Knowledge, Social Skills, Problem-Solving Skills	Knowledge, Social Skills, Problem-Solving Skills	Knowledge, Social Skills, Problem-Solving Skills
	4. Most important solutions	Recruiting, Training, Information, Image	Recruiting, Training, Information, Image	Recruiting, Training, Information, Image	Recruiting, Training, Information, Image
	5. Most important actors	C, S, E	C, S, E	C, S, E	C, S, E
Support staff	1. Employment volume change	M	M	M/D	M/D
	2. Skills changes counted	Count 9	Count 9	Count 6	Count 6
	3. Emerging skills needs	Knowledge, Self-management, Social	Knowledge, Self-management, Social	Knowledge, Self-management	Knowledge, Self-management
	4. Most important solutions	(Re)train, Recruit	(Re)train, Recruit	(Re)train, Recruit	(Re)train, Recruit
	5. Most important actors	E, C	E, C	E, C	E, C
Production workers	1. Employment volume change	M/D	M/D	D	D
	2. Skills changes counted	Count 13	Count 13	Count 7	Count 7
	3. Emerging skills needs	Knowledge, Social skills, Problem-solving, Management	Knowledge, Social skills, Problem-solving, Management	Social Skills, Management	Social Skills, Management
	4. Most important solutions	(Re)training	(Re)training	Retrain (to make fit for other sectors)	Retrain (to make fit for other sectors)
	5. Most important actors	S, E, C	S, E, C	S, C	S, C
Plant &machinery maintenance / .	1. Employment volume change	M/D	M/D	D	D
	2. Skills changes counted	Count 7	Count 7	Count 6	Count 6
	3. Emerging skills needs	Knowledge, social skills, Self-management	Knowledge, social skills, Self-management	Social skills, Self-management	Social skills, Self-management
	4. Most important solutions	Recruiting workers from other sectors	Recruiting workers from other sectors	Retrain (to make fit for other sectors)	Retrain (to make fit for other sectors)
	5. Most important actors	S, E, C	S, E, C	S, C	S, C
Labourers	1. Employment volume change	D	D	D	D
	2. Skills changes counted	Count 7	Count 7	Count 7	Count 7
	3. Emerging skills needs	Knowledge, Social skills, Self-management	Knowledge, Social skills, Self-management	Social skills, Self-management	Social skills, Self-management
	4. Most important solutions	Up-skill, Retrain	Up-skill, Retrain	Up-skill, Retrain (to make fit for other sectors)	Up-skill, Retrain (to make fit for other sectors)
	5. Most important actors	E, C	E, C	E	E

C=Companies; S=Sectoral organisations, U=trade Unions; E=Education and training institutes; G=Government (EU, Member State, regional, local).

Main Other Conclusions and Recommendations

1) Improve the image of the sector – to the young and to society at large

The chemicals sector is perceived by some as a dirty and declining industry instead as a modern sector which is key in searching for and providing sustainable solutions. There is need to better communicate the message across of being a motor ("enabler") for innovation with a positive future that can help solve challenges such as climate change. Stakeholders should work together to convey this positive message, particularly to the young.

2) Bring 'chemicals' to school as early as possible

Research shows that interests and affinity for science is sparked at very early age. To interest future generations for the chemical sector they need to be fascinated early on in school. This can be achieved through integrating important and interesting subjects such as climate change and pollution bringing together the different fields of physics, chemistry and biology.

3) Invest strongly in human capital and lifelong learning

In order to meet the skills needs, enhanced investment in human capital is required. Cost sharing mechanisms between actors, such as public authorities, companies and individuals, need to be developed and lifelong learning throughout the lifecycle promoted: learning must be made more attractive to all, e.g. via tax incentives, a change of attitudes in order to integrate learning into all phases of live need to be initiated, i.e. a lifecycle approach to work.

4) Attract top international talent through universities

European universities still enjoy an excellent reputation globally in chemicals attracting considerable international talent. This opportunity should be used to keep top talent in Europe in research and industry. Strict immigration regulation currently makes it difficult for the sector to keep the wanted talent. This requires more flexibility from national governments and cooperation between universities and the sector (firms).

5) Diversify personnel and take positive action

The EU chemicals industry of 2009 is very much a white male and ageing sector. It shows compared to other sectors a striking lack of diversity of its workforce. Female workers as well as ethnic minorities are still greatly underrepresented. A main recommendation therefore is to implement an active strategy of diversification of personnel in all job functions. Personnel diversification would also enable companies to better develop business in new markets. Diversification can be stimulated by positive action, which should go hand in hand with, e.g. more flexible working time arrangements.

6) Standardize basic health, environment and safety regulations

Environmental regulations differ in many European countries lowering the possibilities for job mobility (migration) and posing additional training costs for workers moving between countries. The EU could help cut costs and stimulate mobility by standardizing regulations.

7) Collaborate with all relevant stakeholders and intensify co-operation

To better meet emergent skills needs co-operation between all relevant stakeholders in the sector should be intensified. The challenge to overcome sectoral skill gaps and shortages will only be met sufficiently if stakeholders act in close concert, with sufficient interaction also between the regional, national and the European level. Collaboration is needed on matching of future skills demand and supply, in developing sectoral learning strategies, and in establishing partnerships for innovation, skills and jobs. Social dialogue at the sectoral level is one of the ways to make collaboration happen.